# COLLECTOR FOR CONNECTION TO A HEAT PUMP

The present invention relates to a collector to be connected to a heat pump and is defined in more detail in the preamble of enclosed claim 1.

Such collectors are used to collect heat from and to emit heat to the ground or water respectively, in cases, when the otherwise used principle of more extensively spreading the collector tubes in vertical and/or horizontal direction appears to be less suitable.

US 2 513 373 describes a heat pump system, in which a number of collectors are connected in series. The collectors consist each one of them of a small number of upwardly and downwardly extending tubes, connected to each other by means of bends, located at the ends and provided with ribs in order to improve the heat receiving capacity. Also, the mutual location of the tubes is fixed by means of particular cross bars. Each end bend must not solely be mounted between two adjacent tube ends but also be fixed in a certain angle in relation to each tube in order to obtain the desired geometrical shape of the collector. The ribs are of course , when this is carried out, an additional problem, whether or not they are already fastened to the tubes or will be fastened to them afterwards. This old technique is very material and labour intensive and also lacks deaeration possibilities. Air is likely to remain in the end bends and it is very difficult to remove it from them. Each such air pocket increases the pressure drop in the collector, the flow of heat transfer medium liquid through the tubes decreasing, and it can also cease completely. Such collectors, which are bulky in their mounted shape, result of course in substantial transport and storage problems, since a mounting of the collectors on the place, where they are to be applied, hardly will be considered.

US 5 054 541 describes a collector coil to be positioned in the ground. A descending and a rising coil spiral in a basket-like shape are used. In this case it is almost necessary to use relatively weak tubes in order to be able to bend them. This results of course in a large pressure drop and in large limitations, when choosing the number of collectors. In practice it will be necessary to connect such collectors in parallel, which results in increased material and labour costs and is a drawback, as regards their handling. From a general point of view it is difficult to control the flow in several circuits connected in parallel. It can usually not be noticed, whether the flow is reduced or ceases in any of the circuits. It has been found, that it is very difficult to transport a liquid downwards without a formation of air pockets along the way, which constantly counteract the liquid flow. Also, a special fixture is required in order to obtain the desired collector shape. Since the fixture is relatively weak, in practice it seems to be difficult to guarantee the required shape. No deaeration means are used.

These two already known collectors are only designed to be positioned in large cylindrical or cone-shaped bores. They require in practice always a particular machinery , which is expensive, time-consuming to use and often accompanied by a considerable damage to the surrounding ground.

The object of the present invention is to counteract and as far as possible eliminate the above-mentioned drawbacks and to develop a collector, which by using only a few means is able to perform multiple functions and also allow a desired flexibility as regards various ground and application conditions. Despite an extensive prefabrication it must be possible to be able to carry out the transport and storage in an optimal way. Firstly, an advantageous connection in series of a large number of collectors must be done , but also a connection in parallel , if so desired, e.g. of several such series of collectors connected in series. Finally, the invention must contribute to a careful positioning of collectors in the ground, a substantial

adjustment to possible obstacles, e.g. stones, rocks and also objects, found in the ground, e.g. conduits, by giving the collector varying shapes.

These objects can be attained according to the invention by designing a collector, mainly of the type set forth in the introduction, in the way set forth in the preamble of claim 1.

Additional characteristic features and advantages of the invention are set forth in the following description, reference being made to the accompanying drawings, which depict a few preferred but only exemplifying embodiments of the invention. The drawings show in detail in :

Fig. 1 a-d a collector according to the invention, viewed from the front, from above,, laterally and in perspective ;
Fig. 2 a-d the corresponding views of a bend pair according the invention including the connection element, which connects the two bends ; and
Fig. 3 a-d the corresponding views of a corresponding bend pair according to the invention, which also includes an aeration channel, which connects the two bends with each other.

A collector according to the invention is shown, designated in its entirety with 1. It preferably is made of a plastic material and comprises a large number of mutually parallel tubes 2 with a preferably relatively large exterior diameter, i.e. about 40 mm, in a preferred embodiment. The length of the tubes is in a typical case 1-3 m, preferably about 2 m and the distance between the central axes of two adjacent tubes is 5-20 cm, preferably 10 cm. An arbitrary number of tubes, e.g. 10-25, can form a collector, preferably in a common plane, which facilitates the manufacture, storage and transport as well as a later positioning of the collectors in the ground or water.

Adjacent tube ends are usually connected to each other by means of two 90° bends 3, positioned close to each other and to said tube ends respectively , e.g. butt to butt. Such a connection suitably is fixed through welding. On the inlet and the outlet side attachment tubes 4 and 5 respectively suitably are arranged in the same bend line, in which there is of course only one 90° bend, designed to attach the outer collector tube to said attachment . The attachment tubes suitably have such a length, that two collectors, connected in series, which with their respective attachment tubes are adjacent each other, can be connected through conventional tube couplings. When they are connected in parallel , the used attachment tubes are connected to a manifold coupling, which leads to a heat pump, in a way not shown here but known per se. Despite the fact, that it is most obvious, that 180° bends can be used for this purpose, it is possible to use 90° bends to obtain two 90° bends as a mirror-inverted pair in one piece jointly with a connection element 6, which connects the two bends, preferably at the same level as the outermost area of bend legs 7, which will be connected to the corresponding adjacent bend legs 7.

Connection elements 6 for the bends, which will be placed at the bottom of a collector, can be designed according to what is shown in Fig. 2, where the connection element is rod-like, possibly with a tube-like profile, where however at least one section 8, preferably a centrally located section between the shoulders of said bend legs 7 and the ends respectively of bends 7, leading to the bendings, is provided with a bend notch, e.g. in the form of a compressed portion or another type of thickness reduction 9, which suitably is mirror-symmetric jointly with the bend pair for the rest. In this way a folding around section 8 is facilitated , tube connection legs 10 of bends 3 approaching each other along arc-shaped movement paths, symmetry axis 11, which runs through section 8, being used as a rotation axis. In case connection element 6 is a tube, then section 8 suitably is in the form of a compression, which eliminates or at least reduces the inner tube cross section, particularly in case the tube communicates with the interior 12 of the bends.

The design shown in Fig. 3 will be placed on top of a collector, where there is a risk, that air pockets will be formed. In this case connection element 6 is a tube, which communicates with the interior 12 of the bends. A compression or the like 9 can also be used in this case, but an aeration channel 13, which extends through the tube, must not be eliminated.

Such a collector can be mass produced in a finished form in a relatively simple, fast and inexpensive way in a plant. Because it preferably is completely flat, it is possible to store and transport it in an optimal place-saving way. The connection elements guarantee the essential shape of the collector, but they render problem-free shape adjustments possible, e.g. when they are positioned in the ground. Thus, a collector according to the invention can be bent around a large stone or another obstacle in the ground. The positioning of the connector in the ground can be done by means of a digging machine with a minimal bucket width, e.g. a width, which is used, when conduits are to be positioned in the ground. A large number of collectors, e.g. 6-10, can be connected in series after each other, the upper connection elements allowing a satisfactory accessibility during the positioning and possibly later during a control of the collectors. The dug furrow, into which the collectors are to be lowered, may be curved, actually zigzag-shaped, if it is required or suitable.

Possibly contained air is collected in the upper bends of a collector and it is not necessary to compel it to follow the meander shape of the collector tubes, but it can, through the connection elements and their airation channels quickly and without problems, mainly flow directly and horizontally from the collector inlet to its outlet. A quick and complete deaeration mainly is guaranteed in this way.

The connection elements with aeration channels can be bent to a certain limited degree, whereas the connection elements without aeration channels suitably can be

bent to a higher degree, i.e. there is a greater risk for obstacles further down into the ground than at higher levels, and thus, such a distribution of the characteristics of the collector corresponds to the practical conditions to a great extent.

The invention is not limited to the embodiments described above and/or shown in the accompanying drawings, which are to be considered as examples only , which can be modified and supplemented in any arbitrary way within the scope of the inventive idea and the following claims. Thus, it is also possible to start with 180° bends , provided with one connection element, one extended in either direction, which e.g. is half the length of the entire finished connection element. Instead of a connection of two 90° bends to one 180° bend, in this case the two connection element halves , which abut against each other, will be connected with each other, e.g. by welding. Also, the connection element halves can be made a little longer and with different diameters, allowing the meeting ends to be pushed on top of each other, which makes it possible to paste them together. Also, it is possible in the previous case to connect the jointly manufactured 90° bends by means of a wall, a film or the like, the upper connection means of which consists of the connection element.

Despite the fact, that a flat manufacturing and preferably also positioning form of a collector according to the invention ought to be preferred, the invention allows a manufacturing and/or positioning in a rounded or zigzag-shape. Particularly in the latter case various shapes of bending notches in the connection elements can be used , which e.g. render possible up to 90° bent sections of e.g. 2-4 tubes at a time in relation to each other, i.e. 2-4 tubes form a flat portion at a time, which then is bent up to 90° in relation to the adjacent portions. Also, it must be mentioned, that the tubes can be elastically bent apart along a long central portion, e.g. around certain obstacles, since there are between the bends on each side no elements, which limit the movability of the tubes. Particularly the lower bends can alternatively be provided with connection elements in the form of hinges, joints or the like, particularly in the

form of ear-like male parts provided with pins and female parts provided with holes (not shown), which project from tube connection legs 10, which can be snapped together to obtain a durable joint, which to a great extent is bendable and can be shaped in practically any way . Said holes and pins are located in symmetry axis 11.